

BIOLUMINESCENCE IN THE FRESHWATER AMPHIPOD, *HYALELLA AZTECA*, CAUSED BY PATHOGENIC BACTERIA

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Abstract.—Bioluminescence is reported from a freshwater amphipod for the first time. Individuals in a culture of *Hyalella azteca* emitted a continuous greenish-yellow glow, usually at night. Luminescence was always followed by death of the amphipod and is attributed to pathogenic bacteria.

“Living light” is emitted by members of almost all major groups of animals. Monera, Protista, and virtually all metazoan phyla have marine or terrestrial representatives that are bioluminescent. However, luminescence in freshwater animals is uncommon, and to our knowledge has not been reported in a freshwater amphipod. However, bacteria-based luminescence is known in at least one freshwater crustacean, the caridean shrimp *Xiphocaridina compressa*. In Japan, in Lake Suwa and in a stream in rice fields near Sawara, these shrimp become luminescent en masse on hot summer nights. The luminescence is so attractive that the shrimp are protected by the government (Hanada 1955).

Observations

We report herein observations on bioluminescence in the freshwater amphipod *Hyalella azteca* (Saussure) and our reasons for believing that the bioluminescence is produced by pathogenic bacteria. We are not certain of the source of the amphipods or the bacteria. At least some, and probably most of the amphipods came from plants taken from a small spring-fed trout pond on U.S. route 15 about 3 miles north of Leesburg, Loudoun County, Virginia. The amphipods were placed in an aquarium containing guppies that was kept in the second author's house in Silver Spring, Maryland, next to a window with southern exposure. Other possible sources of the amphipods are with plants purchased from local aquarium stores and with plants collected by the second author and her husband, Craig Phillips, from several hot, peaty, rather stagnant pools in Florida.

Whatever the source, the amphipods did not luminesce while the water in the aquarium remained cool. In July and August, however, when the aquarium water reached temperatures as high as 35°C and became cloudy, 1-3 luminescent amphipods were observed during an evening.

Luminescence was a continuous emission of a greenish-yellow glow. It was rather dim, and a darkened room was necessary to observe it. Almost all luminescence occurred at night, but a few daytime occurrences were noted. Some time after an instance of luminescence was noted, usually in the morning following a nighttime observation, a moribund luminescent amphipod or one or more dead amphipods were found at the surface.

The continuous rather than periodic or flashing luminescence, together with the inevitable death of the luminescent amphipods, indicates that the light was

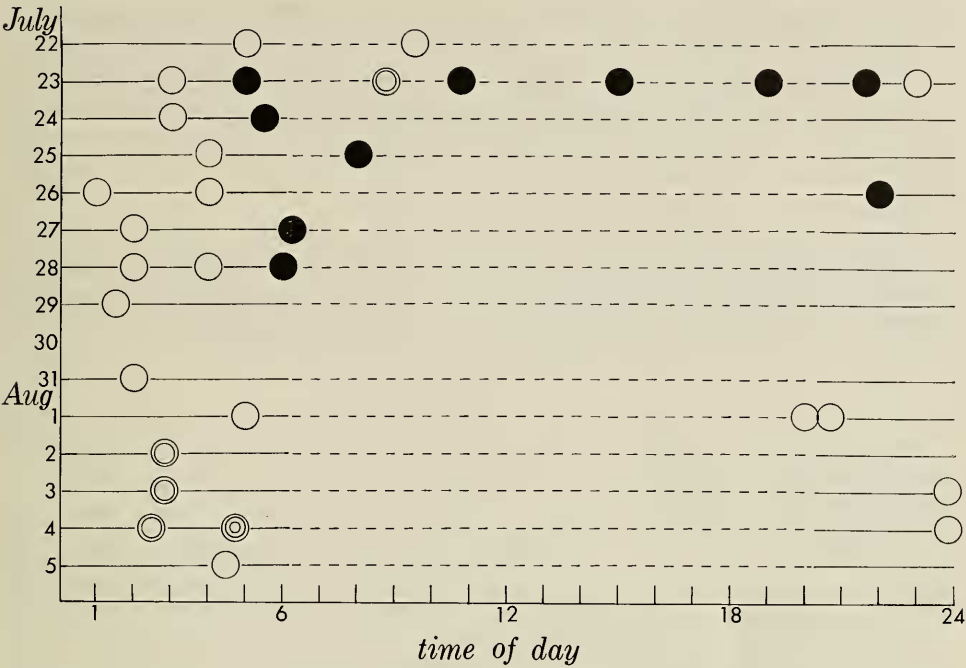


Fig. 1. Observations of luminescence in a gallon jar culture of *Hyalella azteca*. Open circles, luminescence seen; closed circles, no luminescence seen. Concentric circles, 2 or 3 specimens seen luminescing. Daytime (sunrise to sunset) indicated by dashed lines; nighttime (sunset to sunrise), by solid lines.

produced by bacteria that killed the host amphipods. No other explanation appears possible. The light produced by the bacteria was not evident until the latter reached a concentration on the host amphipods that led to the latter's death. Why this concentration was almost always reached nocturnally is not known. Possibly multiplication of the bacteria is inhibited by light. Lacking facilities, we did not attempt to culture and identify the bacteria.

As for the source of the pathogenic luminescent bacteria, the trout pond near Leesburg remains cool in the summer and successfully supports water-cress and introduced rainbow trout. We think it likely that the bacteria came from the Florida plants, or possibly, but less likely, from aquarium store plants.

A series of observations was made on a number of amphipods removed from the aquarium to a gallon jar and monitored for 15 days, from 22 July to 5 August. The jar was kept next to the first author's bed and observed whenever he woke up. Some observations were made in a darkened closet during the day. The results are summarized in Fig. 1. At least one and as many as three amphipods were seen to luminesce each night. During the 15 days, at least 12 amphipods luminesced and died.

Discussion

Luminescence is widespread among marine pelagic amphipods (Herring 1982), but is produced by luminescent organs rather than by luminescent bacteria. Ac-

counts of luminescence in amphipods that must have been caused by pathogenic bacteria date from the early 18th century and are summarized by Harvey (1952). Most of the amphipods involved are beach hoppers of the superfamily Talitroidea, to which *Hyaletta* belongs. A recent account is that of Bousfield and Klawe (1963) for the beach hopper *Orchestoidea gracilis*. Beach hoppers inhabit sandy beaches above the wave line and are terrestrial, in contrast to the completely aquatic *Hyaletta*.

We are unable to explain why, in a culture of dozens of amphipods, only one or two per day developed a growth of bacteria sufficient to produce visible luminescence. Whatever the proximate cause, this pattern of infestation has adaptive value for the bacteria in prolonging the availability of the host.

Acknowledgments

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